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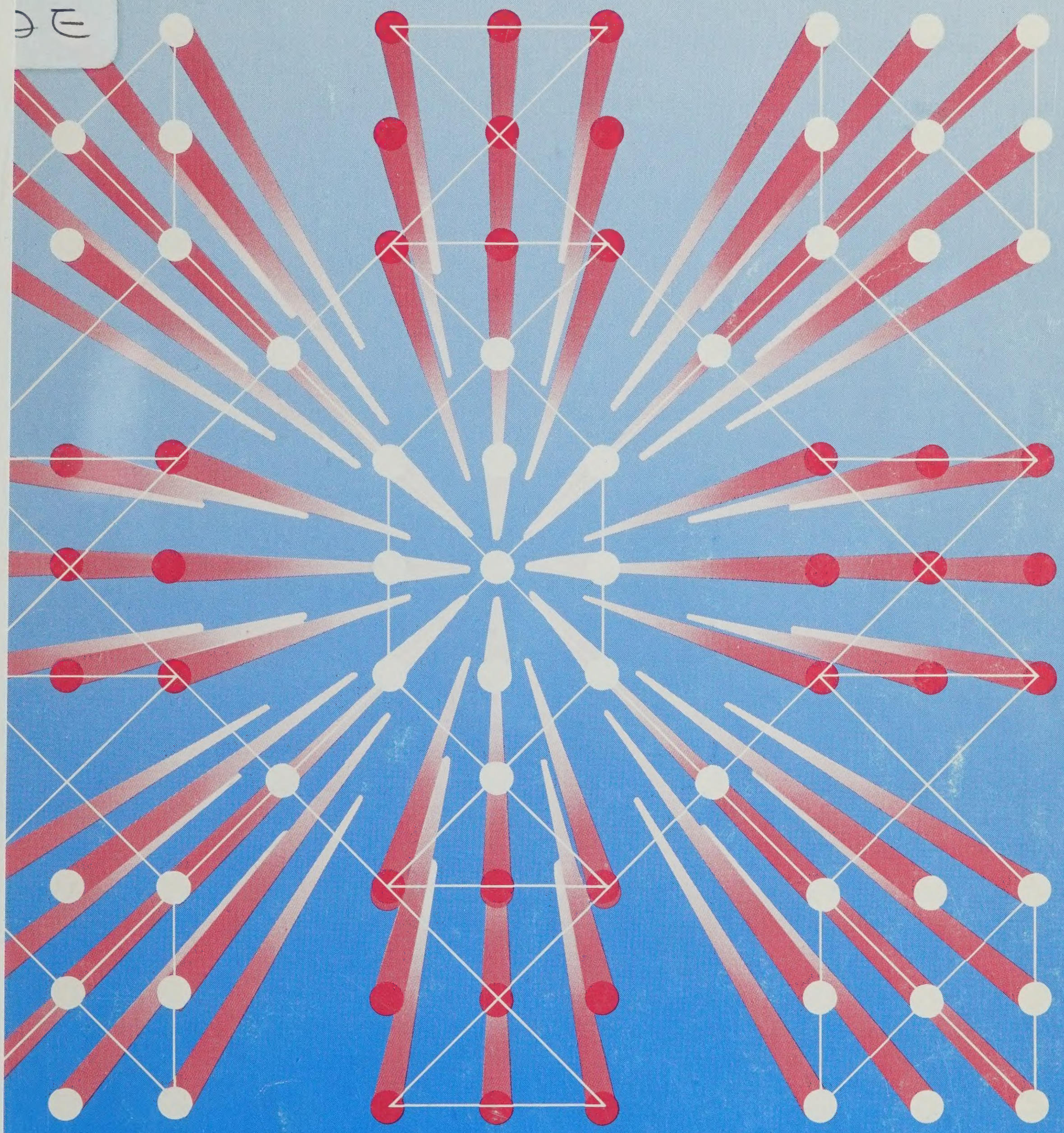

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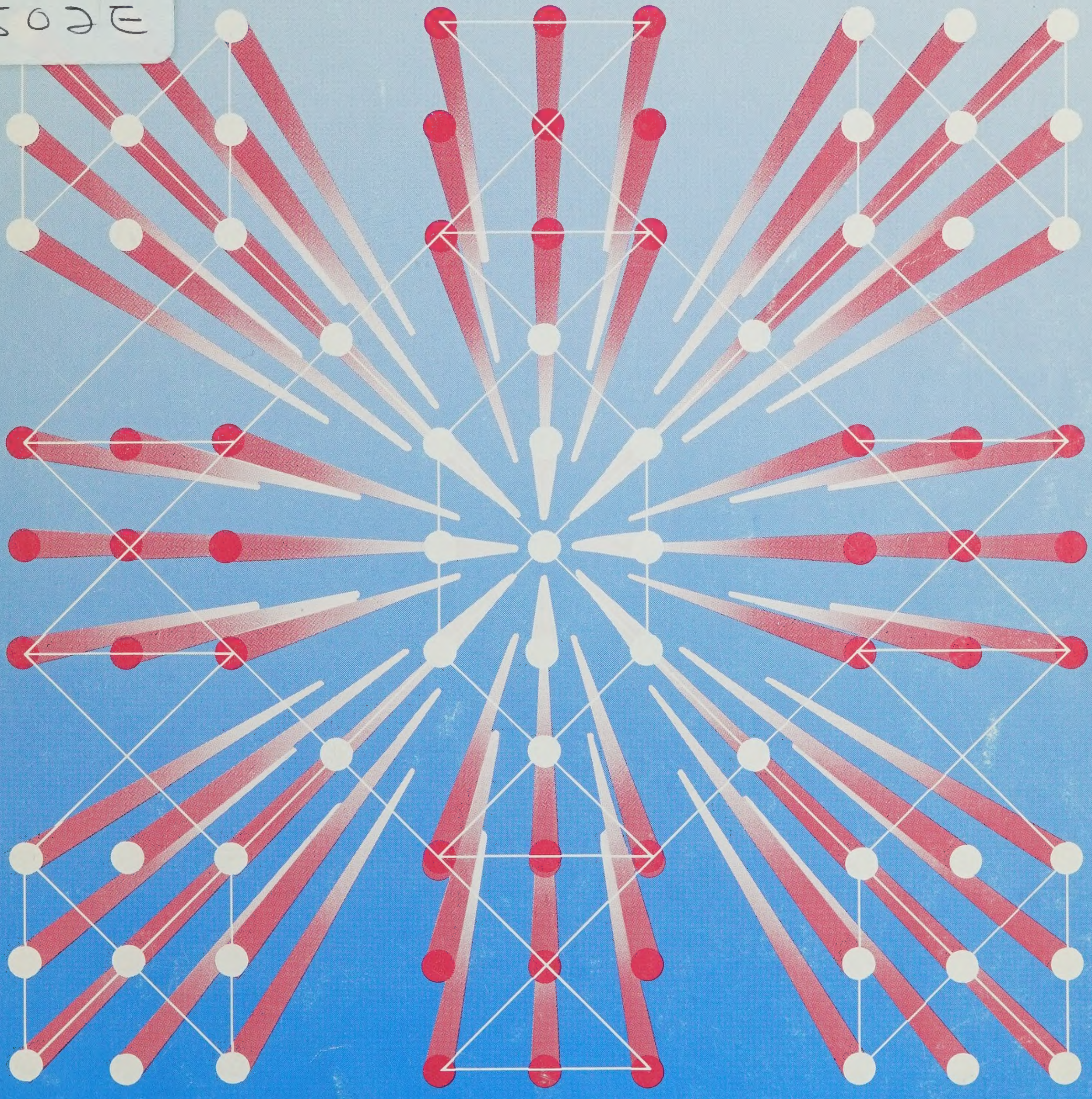
International Payments and Receipts for Technology



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International Payments and Receipts for Technology

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PREFACE

This paper examines the applicability of statistics of international payments and receipts for technology as an indicator of the volume of technological information transferred between countries. Discussions on the theoretical foundations, limitations and uses of international payments and receipts data, and an overview of existing statistics, are provided.

Science and technology indicators may be defined as statistics which measure quantifiable aspects of the creation, dissemination and application of science and technology. As indicators, they should help to describe the science and technology system, enabling better understanding of its structure, of the impact of policies and programs on it, and the impact of science and technology on society and the economy.

International Payments and Receipts for Technology is one of a series of background papers on science and technology indicators to be published by Statistics Canada. The purpose of the series is to describe the theoretical development, limitations and application of various statistics suggested as indicators of science and technology.

Current indicators of Canada's scientific and technological activities include:

- expenditures on research and development;
- federal government scientific activities;
- personnel working in science and technology;
- Canadian research output (citations);
- Canadian patented inventions;
- international payments and receipts for technology;
- trade in selected commodities.

Statistical tabulations of the indicators will be released in **Science and Technology Indicators,** Catalogue No. 88-201, an annual summary; **Industrial Research and Development Statistics,** Catalogue No. 88-202 (Annual); **Resources for Research and Development in Canada,** Catalogue No. 88-203 (Annual); **Federal Scientific Activities,** Catalogue No. 88-204E (Annual); and in a monthly Service Bulletin, **Science Statistics,** Catalogue No. 88-001.

A list of the proposed background papers is included at the end of this publication. These papers represent the opinions of the authors and do not necessarily represent those of Statistics Canada. Comments are invited and should be addressed to Karen Walker of the Science and Technology Statistics Division.

This paper has been prepared by Ernst Kneisel of A.D. Revill Associates Ltd.

Martin B. Wilk
Chief Statistician of Canada

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INTRODUCTION

The set of international payments and receipts for technology is a statistical grouping of the financial transactions made by a country for the purchase and sale of technological know-how and information. The transactions monitor the international flow of these invisible items (i.e., know-how and information) as represented by the payments and receipts recorded for intellectual services (covering management, professional, administrative, consulting, engineering and scientific services, and research and development) and licenses for technological property (covering patents, techniques, processes, formulae and designs). The "balance" is the net of receipts from abroad less payments to foreign countries. A country is said to have a negative balance if payments exceed receipts and a positive balance if receipts exceed payments.

A country's status as an importer/exporter of technology is of economic importance to the government of a country. This has been demonstrated throughout history by the establishment of national policies to control and enhance a country's technological progress and self-sufficiency. Based on the assumption that a firm imports technology to improve its productivity and competitiveness, and it exports technology (usually) to earn profits, these transactions will ultimately affect a country's level of employment and standard of living. Thus, numerical indicators about the inward and outward flows of technology should characterize various aspects of the industrial and economic status, past and present, of a country; and such information could form the basis for forecasts about the future.

The payments and receipts data which monitor the transfer of technological know-how and information provide information about just one aspect of international technology flows. Other measures, such as statistics on trade in selected commodities, must be addressed in any discussion of the international flow of technology.

We now proceed with a review of the various ways in which technology can be transferred (Chapter 1 "International Technology Flows"). The theoretical foundations, limitations and uses of the statistics on international payments and receipts for technology are covered in Chapter 2. Existing sources of data are outlined in Chapter 3 and a brief summary of the above discussions is provided in Chapter 4. The appendix contains excerpts from selected case studies and other background material referred to in the text.

While the attached Bibliography is extensive, this paper has drawn heavily on a relatively small number of printed sources. These are:

"Experimental Studies on the Analysis of Output Part 3: The Technological Balance of Payments", Note by the Secretariat, OECD, DSTI/SPR/83.13, Paris, 1983.

"Report on the Workshop on the Technological Balance of Payments", Note by the Secretariat, OECD, DSTI/SPR/82.9, Paris, 1982.

Madeuf, B., "The Technological Balance of Payments: Problems of Theory, Measurement and Evaluation", OECD, DSTI/SPR/82.62, Paris, 1982.

Stead, H., "The Technological Balance of Payments: Canada", OECD, DSTI/SPR/81.34.04, Paris, 1981.

Baranson, J., **Technology and the Multinationals,** Lexington Books, D.C. Heath and Company, U.S.A., 1978.

Science Indicators - 1980, National Science Board, Washington D.C., U.S.A., 1981.

Discussions on various issues of this paper were held with the three persons listed below, however, they are not responsible for any errors which may appear.

A. Anctil, Vice-President, The SNC Group, Montreal.

A. Hamilton, Government Affairs Officer, U.S. Export-Import Bank, Washington D.C.

A. Zimmerman, President, Noranda Corporation, Toronto.

Chapter 1

INTERNATIONAL TECHNOLOGY FLOWS

This chapter describes briefly the six major ways in which new technology is transferred between countries: product sales, licensing and other agreements, direct investment, free information transfer, joint ventures, and consultant/contractor services. In terms of statistical concepts, product sales are considered "visible items" in technology trade data, while those items (i.e., flows) measured by payments and receipts for technology - licensing and contracted services - are considered "invisibles". Although the other modes of transfer listed are extremely important in today's world technology flows, by the nature of their forms they are also extremely difficult to monitor.

The generalizations made here are supported, in part, by the six case studies summarized in the appendix, and in part by the quotations.

Product Sales

Historically, the conventional method of transferring technology has been via the sale of the end-products which embody the technology. This mode of transfer is measured statistically by indicators of international trade in commodities selected according to their technological intensity. Protective tariffs and restrictions legislated by governments with national goals of self-sufficiency and technological advancement have resulted in the growing importance of other means of technology transfer such as licensing, direct investment, purchase of turn-key plants and joint ventures.

Licensing and Other Agreements

Another traditional method of transferring new technology is through the sale or lease of the rights to use a new process or to manufacture a new product, by the innovating firm to a foreign company. Payments can take the form of a lump-sum amount and/or fees payable for the continuing use of the technology or know-how based on the extent of that use. There will often be non-financial terms in agreements concerning transfers of related information or rights.

Direct Investment

Science Indicators - 1980 provides an excellent overview of the transfer of technology via direct investment abroad:

"Another method of transferring technology is through establishing overseas subsidiaries. Many firms have decided to become 'multinational' in order to exploit a technological lead or because foreign import restrictions make the establishment of overseas production facilities the only viable way a firm can introduce its products into a foreign market. Although it is difficult to determine how much technology is transferred through direct-investment activities abroad, multinational firms do transfer technology in a variety of ways. They train technicians and managers, communicate information and capabilities to engineers and technicians, help client companies use their products more effectively, and assist suppliers to upgrade their technologies. Furthermore, the extent of direct investment abroad greatly affects the amount and value of licensing agreements and the amount of U.S. R&D performed abroad."(1)

Free Information Transfer

Technology transfer via the medium of free information exchange, though difficult to measure, probably comprises one of the basic forms of world technology flows. This kind of transfer covers the following: training personnel, technical meetings and conferences, printing and distributing technical sales literature, exhibiting at international trade shows, publishing books and technical papers, education on technical subjects, management and control systems. The permanent or temporary migration of persons with knowledge of scientific and technical value results in effectively comparable transfers. Free information transfer also includes theft via copying product innovations, proprietary software and know-how.

(1) **Science Indicators - 1980,** National Science Board, Washington D.C., 1981, p. 27.

Joint Ventures

The World Bank Organization encourages the practice of transferring the accompanying skills and expertise with the transfer of technology; and it deliberately fosters the development and establishment of exportable expertise (via local consulting firms) within the developing countries themselves.

A study on the "joint venture" as a method of accomplishing this objective was conducted by Peter Barnard Associates of Toronto for the World Bank Organization. A report on the study (completed March 1983) contains descriptions of five joint venture projects, two of which are reproduced in the appendix. Conclusions which may be drawn from these projects are:

- A real development project is undertaken with the participation of the best foreign expertise available.
- The primary stated purpose of the project is to train nationals - not only to the point where they will be able to operate the new industry but to the point where they will be able to sell their newly acquired expertise abroad as consultants in their own right. The secondary purpose is the project itself.
- The projects take one of two basic approaches to the joint venture: the short-term "contractual joint venture"; or the long-term "equity joint venture" in which a new company is incorporated and governed by corporate law in the recipient country.
- Managerial skill transfers are considered to be as important as technical skill transfers.
- The host government plays a critical role in funding and negotiations.

The significance of these projects lies less in the particular level of technology being transferred and more in the techniques of the transfer; the apparent ease with which state-of-the-art technology can be delivered to any country; and the recognition that technology is more a matter of knowledge and know-how than it is of machinery.

Consultant/Contractor Services

With the technological developments of recent years, there has been a growth in consultant/contractor firms which will provide the know-how and/or act as the middleman in its transfer.

A recent study of the European process plant contracting industry estimated the market for its services to be of the order of $70 billion for 1982 in Europe alone. There are approximately 100 firms in this industry, some of which have their own research and development (R&D) facilities. The study describes their services as follows:

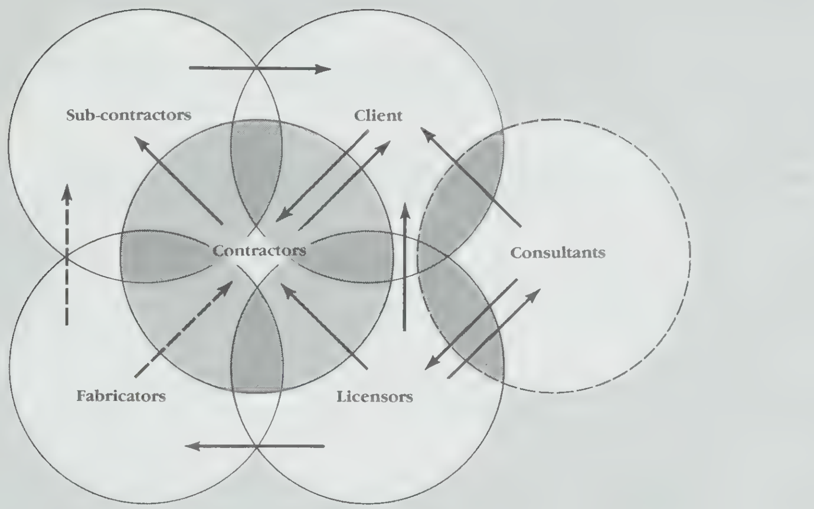
"The process plant contractors...are capable of developing or otherwise obtaining a process license, designing the plant, procuring the equipment, supervising the construction and initiating the operation prior to handing over the plant to the process industry client. ...The contractor's capacity is qualified manpower rather than machinery, and the primary function is to produce a complete process plant in full working order at the site of the client."(2)

In Canada the "SNC Group" is an example of this kind of firm, acting as both consultant and contractor. SNC is capable of delivering, usually with a partner or partners, almost any kind of industrial or civil technology to anywhere in the world. The firm's size is indicated by the fact that its sales for 1983 are expected to approach $300 million; the staff totals 4,500 employees located around the world.

The relationships between consultants/contractors and clients are depicted in Chart A. The solid arrows show the cross-exchange of know-how between the contractors, client, consultants, licensors, fabricators and sub-contractors; the dashed arrows show the exchange of hardware.

(2) **Future Outlook and Opportunities for the European Process Plant Contracting Industry in World Markets,** Information Research Limited, London, U.K., 1982, p. 8.

CHART A. Relationships in the Industry



Source: Information Research Limited

Examples of Major Technology Transfers

Technology and the Multinationals by J. Baranson provides individual cases of technology transfers from the aircraft, consumer electronics, chemical engineering and automotive industries. These are summarized in the appendix.

Matters of significance illustrated by these case studies and from other literature in the field are:

- Technology transfer may be unrelated to the normal commercial environment of the firm. The Brazil-Piper Aircraft case provides an example of a "government-arranged" transfer. It is clear from this example that the resultant economic and business relationships were due to the necessity of accommodating the Brazilian government's aspirations.

- Some technology is transferred not to exploit a market, but to retreat from exploitation for strategic and financial reasons. This is the case of the sale of Motorola's North American plants to Matsushita of Japan.

- The costs of R&D have risen to the point where, on the one hand it has caused some firms to leave the field (e.g., Motorola) and on the other, it has forced the pooling of industrial resources among competing firms. Within the micro-electronics field for example, five firms entered into joint venture agreements for which one of the purposes was to obtain support for R&D activities.(3)

- Consulting firms, in partnership with governments (via joint venture agreements), are creating firms with proprietary know-how. In doing so, they are actually selling technology and know-how as commodities. The Fluor Corporation is an example of this type of consulting firm.

- Shortage of capital funds can be the occasion for the start-up of shared production facilities with a highly competitive country by the innovating firm. The Cummins Engine case exemplifies this phenomenon.

(3) Baranson, J., **Technology and the Multinationals,** Lexington Books, D.C. Heath and Company, U.S.A., 1978, p. 5.

When governments deliberately manipulate and protect their domestic markets, the only entry by foreigners might be to transfer technology and capital to domestic companies in order to acquire a share of the market. This is exemplified by the General Electric-SNECMA joint venture for the production of an aircraft engine in France.(4) A tabular summary of this project is presented in the appendix.

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(4) **Ibid.**, p. 23.

Chapter 2

PAYMENTS AND RECEIPTS FOR TECHNOLOGY: CONCEPT, LIMITATIONS AND USES

Concept

The group of transactions covered in payments and receipts for technology are sometimes referred to as the technological balance of payments (TBP). The TBP, as a statistic, is variously defined by different authorities as follows:

"A technology payment represents the financial counterpart of a (technology) transfer. ...Thus the TBP constitutes statistics on payments and receipts for technology...grouped together as technological balances of payments."

Madeuf, B., "The Technological Balance of Payments: Problems of Theory, Measurement and Evaluation", OECD, DSTI/SPR/82.62, Paris, 1982.

"It (TBP) comprises all those operations concerning invisible transfers recorded in a country's balance of payments which relate to the purchase and sale of technological know-how and information."

OECD Announcement of a Workshop on the Technological Balance of Payments, 14th and 15th December 1981.

"Operations which <u>should</u> be considered for the TBP are:

- licensing of industrial designs, patents, production processes and trademarks;
- engineering and scientific services; and
- R&D.

Forms of technology transfer which should <u>not</u> be included in the TBP are:

- sale or donation of equipment, materials or goods;
- non-commercial technical assistance including the training of personnel; and
- migration of technical personnel."

Stead, H., "The Technological Balance of Payments: Canada", OECD, DSTI/SPR/81.34.04, Paris, 1981.

Thus, before proceeding to analyse and interpret the data on the TBP, the definition employed and any accompanying caveats must be stated. As well, it should be noted that TBP is a crude measure of only one aspect of world technology flows and as such, should only be used in conjunction with various other indicators.

Limitations

The effectiveness with which figures for payments and receipts for technology indicate transfers of know-how depends on the proportion of total real transfers covered by TBP items; and the consistency of that proportion over time. If the TBP consistently accounted for the <u>same</u> percentage of total tansfers, the indicator would tell us the timing, direction and indirectly, the amplitude of changes in volume of transfers; however if the percentage changes, we may lose track of direction and amplitude.

Chart B lists the modes of technology transfer included in as well as excluded from TBP data. Comparing these two lists suggests that some modes are alternatives to each other from the point of view of a firm holding a competitive advantage in technology. The choice of mode is determined on the basis of cost-benefit studies or assumptions covering each possible route, long term and short term. Some factors affecting the choice would be the regulations, tariffs and attitude of the relevant governments; the expenses and risks involved for each route, including the concessions and/or subsidies available; and the overall competitive environment.

CHART B. Modes of Technology Transfer

Technology transfers covered by TBP	Technology transfers not covered by TBP
Licenses covering: Patents Techniques Processes Formulae Designs	Commercial transfers including: Commodity trade Direct investment in branch plants Joint ventures formed specifically to transfer technology Contractors' sales of turn-key plants
Management services Professional and administrative services Consulting services Research and development Engineering and scientific services	Non-commercial transfers including: Donation of equipment or materials Technical training and assistance Migration of technical personnel Internal corporate transfers Trade exhibits Cross-licensing on a non-cash basis Books and journals

Opinions of experts in the field suggest that preferred methods of transferring technology do indeed vary between countries and industries, and over time. Some trends are highlighted below:

- Most of Canada's transfers of technology occur between U.S. parent companies and their Canadian subsidiaries. In comparison, Japan until the early 1970s, bought its technology so that transfers were between unaffiliated companies. Since then, Japan has liberalized its policies on direct investment by foreign firms and the proportion of transfers between affiliated firms has increased substantially.(5) What happened in Japan seems to be part of a world-wide trend: exports have been conventionally assumed the basic media of technology transfer, but a recent study(6) reports that the establishment of foreign subsidiaries is now the most frequently used method, followed by exports, licensing and joint ventures.

- The TBP statistic may over- or under-state the actual volume of technology transfer depending on the mode of transfer used and the practices of the firms involved. It is difficult, however, to say in which direction it will occur: transfers between affiliated firms might well overstate the value of the technology if the charges are a means of getting money from the subsidiary's country to the parent company's country with minimum tax charges. On the other hand, the charges between affiliates might be understated if the parent firm is content to benefit from the transfer in the longer term via improved profits and financial growth for the subsidiary.

- In cases of unaffiliated transfers the true value of the technology is more likely to be consistently understated because the payments statistics fail to reflect other means of payment to the licensor such as tie-in sales agreements to purchase intermediate goods or the exchange of rights to other forms of assistance, services or technology.

- Multinationals have available to them most of the options listed in Chart B for the transfer or exploitation of technology. Given the existing options and the attitude of the receiving countries, it is obvious that considerable swings in the mode and timing of transfers may take place from year to year. In **Science Indicators - 1980**(7) the chemical industry was noted as using subsidiaries as the primary means of transferring proprietary technology. In the report(8) on the chemical and process industry in Europe, it is estimated that the market for the direct sale of proprietary chemical technology is approximately $70 billion annually. Such sales involve virtually a whole industry consisting of some 100 independent contractors who buy much of their know-how from operating companies.

(5) **Science Indicators - 1980**, op. cit., p. 26.
(6) **Ibid.**, p. 35.
(7) **Ibid.**, p. 26.
(8) **Future Outlook and Opportunities for the European Process Plant Contracting Industry in World Markets**, op. cit., p. 4.

The recent recession saw a strong revival of protectionism internationally. This might well moderate if the world economy again starts to expand with the result that preferred methods of technology transfer will also change.

In summary, at least some of the major variables which influence the relevance and usefulness of the TBP data must be acknowledged to be subject to continual and sometimes radical change. This re-emphasizes the point made by field experts that TBP data are of use only in conjunction with various other indicators of technology flow.

The limitations of the concept of the TBP as an indicator of all possible technology flows are covered exhaustively by the following quotation from the OECD Note referred to earlier:

"Between the technological balance of payments, as it actually exists as part of the balance of payments accounts, and international flows of technology, there are gaps which show the general difficulty of making practical data collection reflect underlying economic realities. Certain of these gaps result from the source and accounting content of the technological balance of payments: the technological balance of payments includes only monetary transactions. Transactions in kind, such as actions or obligations offered in exchange for technology, exchanges of technology between firms, and often flows of technology from a multinational to its foreign subsidiaries do not enter the technological balance of payments.

"Data are often underestimated: for fiscal and other administrative reasons, firms tend to furnish the least information possible concerning their technological transactions. This can result in, for example, the declared receipts in country X from country Y being less than the payments declared in Y towards X. This underestimation is probably less in countries where the declaration of technological receipts and payments is required by law than in countries where firms are simply asked to supply information.

"The nature of the information collected varies from country to country. In some countries, payments for patents, licenses and know-how are combined with payments for the use of trademarks, models and industrial designs, and even for payments for artistic property (copyrights, sound and recording rights). Some countries include payments for technical studies and assistance, of which there are two sorts: technical assistance furnished as part of a sale of patents and licenses, and payments for services unconnected to transfers of patents, licenses, and know-how, including personnel training, market studies, establishment of production control systems, expert consultations, etc. In some cases, one can evaluate the importance of flows associated with trademarks and service fees. The United States includes management fees, payments for technical assistance which concern essentially technology between parent firms and subsidiaries and rarely involve non-affiliated firms.

"One must distinguish between affiliated and non-affiliated firms. Since technological payments between subsidiaries and parent firms are not always made at market prices, but at a much higher price, reflecting the strength of the parent vis-à-vis the subsidiary, some countries do not count transactions between affiliated firms. Others count such transactions separately, while a third group of countries includes only global data, with transactions between unaffiliated firms not counted separately.

"Transactions between parent firms and subsidiaries play such an important role in the transfer of technology that it is essential that they be taken into account explicitly. In the United States in 1978, such transactions accounted for 80% of all technology transfers. This figure reflects the establishment abroad of American firms. Finally, the technological balance of payments does not offer information from one country for a given year. The data does not permit one to evaluate the situation for 1980, for example, because the receipts and payments for that year reflect all contracts currently in force, which may have been signed 5, 10 or even 15 years previously. One can therefore not evaluate the situation for contracts signed in any one year, such as 1980. This poses a serious problem, as during 10-15 years a country's technological problem can change radically. For Japan, there is information on both contracts in force and on new contracts, those signed during the current year, which shows that the Japanese deficit falls considerably if one takes into account only contracts signed in recent years, but remains large for all technological transactions made since, for example, 1972."(9)

The range of international practices and opportunities for over- and under-statement described in the above quotation unquestionably complicate the relationship between recorded payments and receipts for technology and the global flow of technology. Thus the limitations to the statistical TBP are both theoretical and practical.

(9) "Experimental Studies on the Analysis of Output Part 3: The Technological Balance of Payments", Note by the Secretariat, OECD, DSTI/SPR/83.13, Paris, 1983, pp. 17 and 18.

Uses

With all of the limitations and omissions implicit in the statistics on payments and receipts for technology as indicators of the technological status of a nation, it still provides a useful review of the overall world technology picture. When the newly augmented statistical series of the Balance of Payments Division and of the Corporations and Labour Unions Returns Act (both of Statistics Canada) are operational, the Canadian indicators will improve significantly. The series referred to will be described fully in Chapter 3.

The OECD is establishing a data bank for payments and receipts for technology and will begin to issue statistics for selected countries in 1984.(10) Statistics from the OECD countries, and especially from the United States, are of great importance, both for the development of TBP concepts and for amplification of the Canadian data.

Policy to encourage the creation, acquisition and use of state-of-the-art technology in Canada must find its guidance in indicators like the TBP. The more such indicators can be made current, and the broader their field of application, the greater their use will be.

From the point of view of industry, the value of the basic indicator for flows of technology would be greatly enhanced if it could be updated on a regular or periodic basis by a survey of intelligence on major transfers of technology. Mere knowledge of the existence of an innovation is often useful in encouraging comparable development; hence, Canadian industry should benefit from such intelligence. In addition, such an on-going survey might promote faster interaction among potential innovators and developers of technological change.

A general view on the use of statistics on payments and receipts for technology is well stated in the following quotation from **Science Indicators - 1980:**

"At present, the magnitude and significance of technology transfer cannot be accurately assessed...because of the enormous difficulties in determining the actual utilization of the technology, measures of what may be more properly termed technology and information flows will sometimes be presented as indicators of technology transfer. While all the indicators in the following discussion have limitations as measures of technology transfer, considered together they can present a picture of what is occurring in U.S. technology transfer transactions abroad."(11)

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(10) "Committee for Scientific and Technology Policy - Secretariat Work on Output Indicators", OECD, SPT(84)8, Paris, 1984.

(11) **Science Indicators - 1980,** op. cit., pp. 24 and 25.

Chapter 3

EXISTING STATISTICS

Within Statistics Canada, four divisions produce statistics which are relevant to the Technological Balance of Payments. In the United States TBP data are gathered by the Department of Commerce's Bureau of Economic Analysis. TPB data are also presented by the National Science Board in **Science Indicators.** A third major source of both TBP data and their analysis is the Organization for Economic Co-operation and Development, through the Science and Technology Indicators Unit of the Directorate for Science, Technology and Industry. A brief summary of the various data available by source is now provided.

Statistics Canada

Science and Technology Statistics Division (STSD)

The STSD annually surveys all firms performing or funding R&D. Amongst other items, it collects data on payments made abroad for R&D and on receipts from abroad for R&D. It also asks firms involved in R&D to report payments and receipts for "patents, licenses and technical know-how". These statistics are available by industry when there are enough observations to permit publication without disclosure but transactions with individual countries cannot be identified. Since the survey is of R&D performer/funder, the technological payments (or receipts) of other firms are not included. However, a survey carried out several years ago suggests that the omitted amounts are not large.

Table 1 is an example of the information provided by STSD in **Canadian Science Indicators, 1983,** Catalogue No. 88-201.

TABLE 1. Technological Balance of Payments, Selected Industries, 1981

Selected industries	Payments	Receipts	Net payments
		millions of dollars	
Mines and wells	26	29	3(1)
Manufacturing	463	130	333
Business machines	144	31	113
Communications equipment	70	33	37
Petroleum products	37	7	30
Chemical products	56	24	32
Other manufacturing	156	35	121
Services	4	8	4(1)
Total	**493**	**167**	**326**

(1) Net receipts.

Note: R&D accounts for 39% of the payments but 81% of the receipts; most of the net payments are due to the purchase of technological know-how and rights.

Source: Canadian Science Indicators, 1983, Catalogue No. 88-201, Statistics Canada, Ottawa, 1983, p. 90.

Balance of Payments Division

This division of Statistics Canada collects statistics annually on financial transactions between Canada and other countries. Every four years a special survey is conducted which identifies the types of payments for various business services, and the country of transaction. In the present context the quadrennial survey is the more important because it collects more data than the annual survey - specifically with regard to the following:

- management and administrative services
- royalties, copyrights, trademarks and film rentals
- consulting and other professional services
- scientific research and product development.

This survey will be conducted annually commencing in 1983. The availability of the data on a continuing basis will strengthen the TBP indicator significantly.

Table 2 is an example of data presented from the 1981 quadrennial survey.

TABLE 2. Business Service Receipts and Payments, By Country of Control, 1981

	Total	Enterprises controlled in:		
		Canada	United States	Other countries
		millions of dollars		
Receipts				
Consulting and other professional services	687	595	60	32
Insurance transactions	133	13	45	75
Management and administrative services	126	80	40	6
Scientific research and product development	79	28	51	-
Commissions	64	12	28	24
Royalties, patents, trademarks and film rentals ..	41	22	12	7
Advertising and sales promotion	40	30	6	4
Computer services	22	15	7	-
Equipment rentals	8	3	3	2
Franchises and similar rights	5	3	2	-
Other services	806	98	666	42
Total survey results	**2,011**	**899**	**920**	**192**
Payments				
Royalties, patents, trademarks and film rentals ..	769	60	620	89
Special tooling and other automotive charges	638	-	638	-
Consulting and other professional services	603	395	192	16
Management and administrative services	603	43	529	31
Scientific research and product development	280	48	208	24
Insurance transactions	203	15	136	52
Commissions	168	75	62	31
Computer services	63	3	58	2
Equipment rentals	52	3	45	4
Advertising and sales promotion	42	18	21	3
Franchises and similar rights	12	5	6	1
Other services	189	42	128	19
Total survey results	**3,622**	**707**	**2,643**	**272**

Source: Quarterly Estimates of the Canadian Balance of International Payments, Second Quarter 1983, Catalogue No. 67-001, Statistics Canada, Ottawa, 1983, p. 28.

In 1972, the Balance of Payments Division carried out an extensive survey of international licensing agreements. Agreements involving payment-free arrangements such as cross-licensing were included. Table 3 is an example of the data available from that study.

TABLE 3. Licensing Agreements Acquired by Canadian Enterprises, by Country of Control and Enterprise Industry of Licensee, 1972

		Petroleum	Manufacturing	Mining	Merchandising	Financial	Other	Total
Licences reported	No.	164	2,523	49	483	10	188	3,417
Licences covered by master agreements	"	51	1,465	15	389	8	60	1,988
Master agreements	"	23	682	10	92	8	52	867
Licences by country of residence of licensor:								
Canadian subsidiary of foreign company	"	4	108	7	24	-	2	145
Other Canadian licensors	"	4	128	4	9	-	7	152
United States	"	142	1,893	29	394	9	156	2,623
United Kingdom	"	4	103	1	29	-	4	141
Europe	"	7	250	6	25	1	15	304
Japan	"	2	13	-	1	-	-	16
Other	"	1	28	2	1	-	4	36
Licences held from affiliates:								
In Canada	"	-	33	-	5	-	63	101
Outside Canada	"	38	751	1	308	3	53	1,154
Licences held from non-resident individuals or corporations and from Canadian subsidiaries of foreign companies that:								
Vest rights to improvements in licensor	"	38	455	8	277	-	10	788
Allow market access to:								
All countries	"	72	957	39	21	-	107	1,196
All countries other than source of licence	"	2	105	-	6	-	-	113
Same countries other than source of licence	"	8	263	1	22	1	7	302
Canada only	"	78	1,070	5	425	9	67	1,654
Specify mandatory source of supply of materials, components, sub-assemblies or equipment	"	3	227	3	36	-	8	277
Value of purchases from mandatory sources	$'000	50	47,219	42	17,581	-	612	65,504
Payments to non-residents under licensing agreements	$'000	2,186	95,764	237	13,912	416	6,357	118,872
Licensing agreements executed or re-executed in 1972	No.	12	213	5	33	3	32	298

Source: Quarterly Estimates of the Canadian Balance of International Payments, Third Quarter 1973, Catalogue No. 67-001, Statistics Canada, Ottawa, 1973, p. 17.

Corporations and Labour Unions Returns Act (CALURA)

CALURA annually collects and publishes financial data of corporations having gross annual revenues in excess of $500,000, or assets in excess of $250,000. However, as a result of a recent amendment to CALURA, in future, financial data will be collected from corporations having gross annual revenues in excess of $15 million, or assets in excess of $10 million. The purpose of CALURA's activity is to assess the extent and effects of non-resident ownership and control of Canadian corporations. Table 4 below is an excerpt of the relevant portions of a table produced by CALURA covering TBP items.

TABLE 4. Payments to Non-residents by Reporting Corporations, by Payment Type and Country of Control, 1980

Payment type	Total foreign controlled firms	Canadian controlled firms	All firms
		millions of dollars	
Dividends	2,360.3	554.2	2,914.5
Interest	839.5	777.6	1,617.1
Rent	66.9	148.9	215.8
Royalties and similar payments:			
Copyrights	71.9	20.7	92.5
Patents of invention	66.7	10.4	77.1
Industrial designs	56.8	7.5	64.3
Trademarks and trade names	132.9	12.1	145.0
Other	364.0	124.5	488.4
Total	692.2	175.2	867.4
Payments for exercise of production, distribution and sales franchises and similar rights	52.2	14.9	67.1
Advertising and sales promotion	39.6	19.2	58.8
Payments for or in respect of:			
Scientific research	86.8	27.7	114.5
Product and process development research	166.4	3.6	170.0
Total	253.1	31.3	284.5
Insurance premiums and related charges	19.5	5.2	24.7
Management and administrative fees	366.0	59.3	425.4
Salaries, fees and other remuneration to officers and directors	13.9	6.9	20.7
Annuities, pensions and similar payments	0.6	0.8	1.4
Fees and charges for professional services:			
Engineering services	350.9	13.1	364.0
Architectural services	0.1	0.5	0.6
Legal services	7.3	14.5	21.8
Accounting services	15.6	0.5	16.1
Auditing services	2.6	0.8	3.4
Total	376.4	29.4	405.8
Consulting fees and other charges not included in any of the above payments	368.6	38.3	406.9
Total all payments	**5,448.8**	**1,861.2**	**7,310.0**

Source: **Corporations and Labour Unions Returns Act, Report for 1980, Part I – Corporations,** Catalogue No. 61-210, Statistics Canada, Ottawa, 1980, p. 263.

In future, annual statistics will be available on some licensing agreements. Certain respondents transferring technology from abroad will be asked to provide information on the subject of the agreement, the royalties due, the rights of the licensee and the restrictions on the licensee.

Merchandising and Services Division

This division of Statistics Canada carries out a quadrennial survey of consulting, engineering and architectural establishments. Data requested include fees earned and expenses incurred in foreign contracts. Table 5 shows the kind of detail available.

TABLE 5. Location of Foreign Projects, by Geographic Area, by Sector, 1978

Sector	United States	Europe	Latin America	Caribbean	Middle East	Far East	Africa	Austra-lasia	Total
	thousands of dollars								
Agriculture, fisheries, forestry, forest products	x	x	5,931	357	x	523	522	x	16,162
Air and sea ports, harbours and terminals, coastal works	–	x	x	1,382	1,121	1,922	1,284	–	5,920
Bridges, tunnels, highways and railways	x	–	x	x	x	x	621	x	2,442
Buildings	1,411	x	x	x	x	258	x	–	5,769
Dams, irrigation and flood control	x	x	x	x	x	5,959	3,536	x	10,826
Plant process design	1,137	x	2,389	x	x	4,317	3,633	x	37,397
Mining and metallurgy	4,545	988	789	x	x	x	2,752	453	11,126
Municipal services	404	–	x	544	860	x	4,441	–	7,454
Petroleum and natural gas	1,901	1,588	x	–	x	x	2,658	x	6,648
Power generation, transmission and distribution	x	649	15,450	954	4,715	16,077	19,320	x	62,132
Telecommunications	x	x	x	x	x	–	x	–	4,869
Miscellaneous	1,887	159	169	x	144	x	805	x	5,961
Total	**24,338**	**16,121**	**28,525**	**12,079**	**17,274**	**33,562**	**41,770**	**3,037**	**176,706**

Source: Engineering and Scientific Services, 1978, Catalogue No. 63-537, Statistics Canada, Ottawa, 1980, p. 26.

United States

Bureau of Economic Analysis (BEA), Department of Commerce

Since such a large part of Canada's international trade is with the United States, transactions with this country have a major influence on the Technological Balance of Payments. The BEA provides a summary of U.S. international transactions in royalties and fees in its **Survey of Current Business.** These are broken down between affiliated and unaffiliated companies and by major industry.

In addition, every six years the BEA conducts an in-depth study of United States international transactions. The most recent one is entitled "U.S. International Transactions in Royalties and Fees, 1967-78" and its results appeared in the January 1980 issue of **Survey of Current Business.** Tables used for the analysis included:

- U.S. International Transactions in Royalties and Fees with Affiliated and Unaffiliated Foreign Residents, 1967-1978.
- U.S. Receipts of Royalties and Fees, by Industry, 1967-1978.
- U.S. Receipts of Royalties and Fees, in Manufacturing, by Area, 1978.
- U.S. Payments of Royalties and Fees, by Industry, 1967-1978.
- U.S. International Transactions in Royalties and Fees with Affiliated Foreign Residents, by Area, 1967-1978 (see Table 6).
- U.S. Receipts of Royalties and Licensing Fees from Affiliated Foreign Residents, by Area, 1967-1978.
- U.S. International Transactions in Royalties and Fees with Unaffiliated Foreign Residents, by Area, 1967-1978.

An example of the statistics published is shown in Table 6.

TABLE 6. U.S. International Transactions in Royalties and Fees(1) with Affiliated Foreign Residents, by Area, 1967-1978

Year	Total	United Kingdom	European Communi- ties(2)	Denmark and Ireland(3)	Other Europe(3)	Canada	Latin American Republics and Other Western Hemisphere	Australia, New Zealand, Republic of South Africa	Japan	Other
					millions of dollars					
Receipts:										
1967	1,123	153	237	(4)	78	242	175	62	37	140
1968	1,246	161	275	(4)	79	265	213	68	45	139
1969	1,356	183	297	(4)	99	267	232	76	53	150
1970	1,561	217	354	(4)	104	311	241	90	66	177
1971	1,757	240	424	(4)	112	333	241	107	83	217
1972	1,911	271	473	(4)	131	356	232	115	102	232
1973	2,309	302	625	(4)	157	394	243	152	153	282
1974	2,833	356	767	30	173	517	307	167	190	325
1975	3,251	444	892	43	214	547	349	182	200	380
1976	3,262	448	833	43	215	613	269	179	239	424
1977	3,554	476	961	54	232	652	312	195	279	395
1978P	4,364	649	1,205	72	235	698	323	206	401	573
Payments:										
1967	62	11	-3	(4)	11	43	(5)	(5)	(5)	1
1968	80	21	(5)	(4)	9	47	(5)	(5)	3	1
1969	101	26	2	(4)	13	56	(5)	(5)	4	1
1970	111	19	2	(4)	21	62	(5)	(5)	4	2
1971	118	11	3	(4)	36	64	(5)	(5)	1	3
1972	155	15	6	(4)	72	60	(5)	(5)	1	1
1973	209	20	23	(4)	91	73	(5)	(5)	1	1
1974	160	17	5	2	149	46	-3	-5	-47	-6
1975	287	27	17	1	114	139	14	-2	-26	2
1976	293	8	25	1	131	137	26	-1	-34	1
1977	243	19	37	1	98	118	3	-2	-34	1
1978P	396	75	111	4	121	127	19	2	-66	4

(1) Excludes film rentals, which are included with receipts and payments of royalties and fees in the international transactions tables in the SURVEY.
(2) Original six members only.
(3) When not shown separately, Denmark and Ireland are included with Other Europe.
(4) Not shown separately.
(5) Less than $500,000.
Note: Negative payments represent foreign liabilities to U.S.-based affiliates.
Source: **Survey of Current Business,** U.S. Department of Commerce, Bureau of Economic Analysis, January 1980, p. 34.

National Science Board

The National Science Board is required by law to publish a biennial report on science and technology indicators. This report, entitled **Science Indicators,** has been published since 1972. Among other things, the report analyses the broad flow of developments in the field of technology transfer. This analysis is based on expert opinion, published material of various kinds and on data and studies commissioned by the National Science Foundation. Examples of their presentation of the 1980 issue of **Science Indicators** are shown in Tables 7 and 8.

TABLE 7. Percentage Distribution of R&D Projects,(1) by Anticipated Channel of International Transfer During the First Five Years After Commercialization, 1974-1979

Category	Channel of technology transfer:				
	Foreign subsidiary	Exports	Unaffiliated licensing	Joint venture	Total
All R&D projects:					
16 industrial firms	85	9	5	0	100
7 major chemical firms	62	21	12	5	100
Projects aimed at:					
Entirely new products	72	4	24	0	100
Product improvements	69	9	23	0	100
Entirely new processes	17	83	0	0	100
Process improvements	45	53	2	1	100
Projects where estimated rate of return(2) is:					
Less than 20 per cent	36	19	38	7	100
20 per cent to 39 per cent	46	29	19	5	100
40 per cent or more	100	0	0	0	100

(1) Based on 1974 R&D projects of 23 U.S. firms.
(2) If commercialized.
Source: Science Indicators - 1980, National Science Board, Washington, D.C., 1981, p. 34.

TABLE 8. U.S. Receipts and Payments of Royalties and Fees(1) With Selected Nations, 1967-78

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978p
	millions of dollars											
Total net receipts(2)	1,516	1,683	1,842	2,134	2,375	2,566	3,021	3,584	4,008	4,084	4,474	5,429
Developed countries	1,152	1,271	1,404	1,651	1,856	2,031	2,421	2,857	3,177	3,273	3,639	4,381
United Kingdom	208	214	238	273	306	334	376	427	523	520	558	742
European Community(3) ...	334	388	431	511	585	631	794	954	1,091	1,043	1,187	1,466
Other Europe	107	112	135	142	163	188	216	276	337	345	410	418
Canada	275	296	295	344	365	394	426	555	585	651	694	759
Japan	132	175	208	268	306	342	426	439	419	485	554	744
AZSA(4)	86	86	97	113	131	142	183	206	222	222	236	252
Developing countries	365	411	440	483	520	536	599	726	831	813	837	1,046
Total net payments(5)	166	186	221	225	241	294	385	346	473	482	434	610
Developed countries(6)	163	183	217	216	234	289	376	346	452	451	481	574
United Kingdom	43	56	67	54	48	59	73	84	103	85	91	159
European Community(3) ...	43	51	54	54	58	63	95	75	84	92	100	178
Other Europe	27	22	27	34	54	93	114	173	135	149	120	148
Canada	46	51	60	66	69	66	79	53	148	146	126	137
Japan	11	7	8	8	5	7	14	-35	-17	-21	-18	-51
AZSA(4)	14	14	8	14	14	8	8	-4	-1	(7)	-1	3
Developing countries(6) ...	4	4	5	9	7	6	10	-1	20	33	16	38

(1) Excludes film rentals which are included with receipts and payments of royalties and fees in the international transactions tables in the **Survey of Current Business.**
(2) Represents net receipts of payments by U.S. firms from their foreign affiliates for the use of intangible property such as patents, techniques, processes, formulas, designs, trademarks, copyrights, franchises, manufacturing rights, management fees, etc.
(3) Original six members only.
(4) AZSA = Australia, New Zealand, and the Republic of South Africa.
(5) Payments measure net transactions between U.S. affiliates and their foreign parents.
(6) Estimates within plus or minus $0.5 million of the actual totals.
(7) Less than $0.5 million.
Note: Detail may not add to totals because of rounding. Negative payments represent foreign liabilities to U.S.-based affiliates.
Source: Science Indicators - 1980, National Science Board, Washington, D.C., 1981, p. 229.

Organization for Economic Co-operation and Development

Science and Technology Indicators Unit

The Organization for Economic Co-operation and Development (OECD) has as its mandate in the field of science and technology:

"to study the scientific and technological and industrial policy issues relevant to the overall economic policy problems dealt with by the Organization...and recognizes the need to complement and support macro-economic policy measures by consideration of structural problems of industrial adaptation and change, technological innovation, and research and development."(12)

More specifically the OECD has initiated study and published a significant volume of authoritative papers covering the following topic areas relevant to this present review:

- Technology Transfer by Multinational Enterprises
- Technology Transfer between East and West
- Science, Technology and Development
- Science and Technology Indicators.

In furtherance of this work the OECD holds periodic workshops and conferences at which research papers are tabled, objectives redefined, etc. Much of the research work is not formally published, but is circulated among organizations and persons of the member countries.

Three papers, which together provide a definitive analysis of the TBP and contemporary problems associated with its use, have been published since February 1982. Their titles follow:

"Report on the Workshop on the Technological Balance of Payments", Note by the Secretariat, OECD, DSTI/SPR/82.9, Paris, 1982.

Madeuf, B., "The Technological Balance of Payments: Problems of Theory, Measurement and Evaluation", OECD, DSTI/SPR/82.62, Paris, 1982.

"Experimental Studies on the Analysis of Output Part 3: The Technological Balance of Payments", Note by the Secretariat, OECD, DSTI/SPR/83.13, Paris, 1983.

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(12) **Activities of OECD: Report by the Secretary General,** OECD, Paris, 1982, p. 3.

Chapter 4

SUMMARY

The payments and receipts for technology represent monetary measures of the transfers of technology between countries. The transfers included are those which involve contractual arrangements within and between companies and thus result in identifiable payments. It is well established by analysts that such payments by themselves do not represent a complete nor an accurate measure of the real flows which take place. The problem is basic to statistics: it is occasioned by the fundamental dichotomy between the real world which is dynamic and complex, and numerical descriptions of it which are static and one-dimensional.

Therefore, the TBP must be supplemented by, and interpreted in conjunction with, other measures and descriptions of technology transfers, as well as analysis of background information. Organizations experienced in the use of science and technology indicators, such as the National Science Foundation, rely on groups of indicators rather than single indicators to support studies of topics such as the flow of technology.

An OECD Secretariat Note provides a well-balanced approach to the interpretation of these statistics:

"At the same time there is seen to be a correlation between firms' R&D spending and technology imports and exports. It seems, therefore, that the firms which perform R&D are also those which purchase technology from abroad. Consequently, expenditure on purchases of foreign technology can be regarded as playing the same role as R&D expenditure; in other words, it is an input indicator. It is, therefore, possible to contend that the technological balance of payments' payments and receipts are not perfectly symmetrical: the payments may be an input, whereas receipts from technology exports constitute only one of the possible outputs resulting from firms' activities.

"Because of this asymmetry, purchase of foreign technology and a technological balance of payments deficit are not necessarily a sign of technological weakness. The deficit may instead be the sign, as in Japan's case, of an active policy of technology purchase so as to increase the country's economic competitiveness, provided, of course, that the purchases are accompanied by internal improvement of the technological level, R&D and training."(13)

The following statement from **Science Indicators - 1980** offers simultaneous aknowledgement of both the limitations and the usefulness of the general TBP approach:

"While there are limitations to many of the indicators available to analyze international technology and trade flows, the trends do reinforce one another and thus provide a greater degree of confidence in the findings."(14)

Some major developments of the past few decades have complicated the basic problem of interpretation. One such development is the growth of the multinational enterprise. In many cases technological information passes between units of a multinational enterprise without a parallel and opposite flow of funds, i.e., without an identifiable related effect on the balance of payments. In 1977, foreign direct investment in Canada totalled $47 billion. Non-residents controlled 55% of the capital employed in manufacturing industries, 68% of the capital employed in the petroleum and gas industries, and 55% of the capital employed in the mining industries. It is certain that the flow of technological information for Canada, as measured by the TBP, is greatly understated compared to that of countries with less foreign direct investment.(15) The TBP statistics must be considered with this in mind.

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(13) "Report on the Workshop on the Technological Balance of Payments", Note by the Secretariat, OECD, DSTI/SPR/82.9, Paris, 1982, p.9.
(14) **Science Indicators - 1980,** op. cit., p. 31.
(15) Stead, H., "The Technological Balance of Payments: Canada", OECD, DSTI/SPR/81.34.04, Paris, 1981, p. 2.

Another set of developments has taken place at the national government level: firstly, there has been an increasing drive for technological independence and advancement by both the more and the less-developed countries. This has led to governments themselves playing a major and newly authoritative role in the transfer of technology, inward or outward. Secondly, there has been an initiation of deliberate efforts by international bodies such as the World Bank to transfer technology to the less developed countries.

The impact of these changes is to affect the mode of transfer of technology: in addition to simple inter-firm transfers, licensing, and imports and exports there are an increasing number of joint ventures with consulting or producing firms and governments, as well as direct purchases by governments of capital equipment and know-how from international contractors.

Short-term changes of the kinds just discussed are easy to identify and to measure, however, for long-term or secular changes it is much more difficult. For example, it is now widely recognized that we are in the early stages of a major technological revolution, most visible in the micro-electronics and telecommunications fields. The question of when exactly this revolution started, is almost as difficult to answer as when exactly the Industrial Revolution started.

The point to be made here is that if the short-term changes are identified and monitored, the long-term changes are implicitly covered. This suggests that it is important (a) to maintain the broadest possible reporting basis for statistical evidence of change and (b) to report the current industrial intelligence which presages the statistical changes to come.

The conclusion to be drawn from this examination of the TBP is that efforts should be made to find additional indicators of technological flows and status, to complement the TBP. At this time the statistics on R&D expenditures, productivity, balance of trade in selected commodities, the TBP, and patent registration are all supplementary to each other and certainly provide an overview of trends in national technology. However, all of these data necessarily lag events by months if not years and all share comparable statistical limitations. A more direct approach by the statistical agencies to monitor and communicate current intelligence on technology transfers of all kinds, on a descriptive rather than purely statistical basis, might serve to round out and improve the picture presented by the available statistics.

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Appendix

SELECTED CASE STUDIES

Case 1

The Indonesian Oil Industries Consortium

"The Government of Indonesia has recognized a long-term need to strengthen Indonesian institutions concerned with the development of Indonesian oil resources. Oil operations in Indonesia are centrally controlled by the state enterprise PERTAMINA (Perusahaan Pertambangan Minyak Das Gas Bumi Negara). The international oil companies have been active in oil and gas exploration and processing for many years. They continue to be active in the Indonesian market but now under the aegis of PERTAMINA. The national policy of Indonesia is to develop Indonesian oil resources in the national interest."

An Equity Joint Venture

"In 1974, an equity joint venture, PT Pestaferikki Engineering (PFN), was formed by PERTAMINA (30 per cent shareholdings), the Far East Oil Trading Company Ltd. (Japan 10 per cent shareholder), and Japan Gasoline Co. Ltd. (60 per cent shareholders), a firm engaged in international engineering/construction serving the petroleum refining, petro-chemical, chemical and other processing industries. This joint venture operated to render overall technical services such as consulting engineering, design engineering, procurement, construction, and maintenance for a variety of facilities for the development, production storage and transportation of petroleum and natural gas as well as for petroleum refining, petro-chemical and other chemical process plants."

Serving National Policy

"In 1982, the Indonesian government required the shareholders of PFN to expand and strengthen PFN in accordance with the natural policy of the Republic of Indonesia. As a result, additional shareholdings were added from Indonesian companies, namely:

PT Encona Engineering Inc., one of the larger Indonesian engineering consulting companies (with a staff of 300 professionals) and Indonesian capital goods manufacturers and investment companies.
PT Mega Electric.
PT Boma Stork.
PT Bagun Tjipta Sarana.

"The Indonesian companies hold 65 per cent of the joint venture and the Japanese companies 35 per cent. Ownership and control of the new structure is Indonesian rather than Japanese.

"Recognizing that there was sufficient business potential in oil resource projects for at least two other similar equity joint ventures, the Indonesian government has encouraged the formation of such companies with Fluor and Bechtel - U.S. design/construction companies experienced in the petroleum technologies - as shareholders. As well, the state enterprise, PERTAMINA, will have shareholdings in these other two joint ventures. Government policy is to permit other international companies to continue to compete for future business by means of contractual joint ventures.

"The operating Board of Directors is composed of eight directors, two from JGC Company, one from FEO, and one each from the five Indonesian companies. The operating Board is presided over by a Komisaris made up of senior officers of the shareholding companies. The Komisaris sets policy.

"The Board will be convened and presided over by the President, Director, and Chief Executive Officer appointed by PERTAMINA. There will be two senior vice-presidents, one nominated by JGC and one nominated by Indonesian shareholders. The senior vice-presidents will assist the President in the day-to-day management of PFN, especially in ensuring the transfer of technology and know-how by securing the personnel required."

Emphasizing Skill Transfer

"The purpose of this joint venture is primarily skill transfer. The shareholders' agreement carries the following clauses with regard to skill transfer:

"13 (ii) For the reinforcement of PFN, JGC will continuously execute technology and know-how transfer to PFN, so that PFN can develop its project execution capability in planning, design and engineering, procurement, project control, and construction management. The technology transfer of engineering and project management know-how will be developed and executed through programs which specify the ways, means and periods, so that within 8-10 years, key positions can be transferred to Indonesian personnel.

Such technology transfer shall be planned with due consideration to the Terms of Reference: ACTIVITIES FOR THE UPGRADING OF THE NATIONAL CONTRACTORS AND MANUFACTURERS, published by the Government Supplies/Equipment Procurement Control Team, and shall be carried out in accordance with the agreements between PFN and JGC covering such technology transfer, which agreements shall be approved by the Board.

"13 (iii) Such program will include the positioning of Indonesian personnel in all disciplines, giving them the opportunities to be involved in the decision-making process in each discipline.

"13 (iv) In the Company's organization, it is targeted that the composition of the key positions will be:

	Expatriate per cent	National
First 5 years	75	25
Subsequent 4 years	50	50
Onward	25	75

"13 (v) In the project organization, composition of the key positions will be:

	Expatriate per cent	National
First 3 years	80	20
Second 3 years	70	30
Third 3 years	60	40
Fourth 3 years		
Onward	Will be determined by the Board of Directors	

The above is of target nature and will possibly fluctuate up and down depending on the number, size, and features of projects which PFN will be awarded in future.

"13 (vi) Other shareholders shall also assign permanently to PFN the required number of their engineers and non-engineers on a mutual agreement basis.

"13 (vii) Principal services of such expatriates from JGC when stationed at PFN office as key personnel of the work force within PFN will be:

- To transfer design and engineering practice and project coordination and execution procedures possessed by JGC.

- To transfer systematic know-how and procedures on cost estimation, procurement, expediting, inspection and shipping.

- To train and guide the PFN's staff in the construction management, supervision, start-up operation and maintenance.

- To improve and refine the technical expertise and management capability of PFN's work force in participation with the present and future activities.

- To train and instruct PFN's own staff and associates through daily activities and specific projects in accordance with JGC's engineering and project management procedures.

- To provide engineering and management manuals in English language.

- JGC's Education and Training Department will be specifically responsible for this training of PFN's staff in applying JGC's self-developed Training Program."

Case 2

The Magat River Multi-purpose Project (Philippines)

"The Magat River Project for the Philippine National Irrigation Administration (NIA) provides 540 megawatts of hydroelectric power from a 114-metre high dam and year-round irrigation for 10,000 hectares of domestic and industrial water supply and reforestation.

The project began in 1975 with preliminary studies carried out by the U.S. Bureau of Reclamation funded by U.S. AID. The project continued with a $150 million World Bank loan; a $9 million loan from Bahrain funded foreign costs, and 3.3 billion Philippine pesos funded local costs. The work progressed through a feasibility study phase, a detail design phase, and a construction phase."

A Contractual Joint Venture

"The ECI company and Shawinigan Engineering undertook a $3 million feasibility study over a nine-month period.

"In June, 1978, a joint venture composed of ECI, Denver, U.S.A., the lead company, with Shawinigan Engineering Co., Montreal, Canada, in association with DCCD and EDCOP of the Philippines, was invited to negotiate a $5 million and 13 million peso contract for detailed drawings, tender documents, and construction supervision. All four companies signed the subsequent contract as a unit.

"The U.S. and Canadian companies undertook joint and several liability between the two parties and largely conducted the feasibility phase. The Philippine companies performed half of the work in the subsequent detail design and construction phases but with the foreign companies responsible and having liability for the work. The project was completed in November, 1982.

"The engineering joint venture organized a project staff of 80 engineers 25 of whom were expatriates. This project organization combined engineers from all four companies. The work load split evenly between the foreign companies and the local companies. The NIA authority with a staff of some 3,000 organized a project organization specifically for the Magat project. Some 95 per cent of the drawings were done in the Philippines.

"The project organization was composed of two distinct organizations. The consultant project manager and the client project manager established excellent rapport and in practice were able to meet and talk on a daily basis."

A Program for Skill Transfer

"The Terms of Reference for the engineering joint venture required skill transfer to the professional staff of the National Irrigation Administration. The contract had provisions for skill transfer to the client organization. Two groups of client professionals received training in Denver and in Montreal. Training seminars were conducted for NIA personnel five times a year in the field, and a two-week seminar was provided for office personnel. In addition, NIA personnel travelled to Denver and Montreal. A special seminar on instrumentation for the dam and power plant was organized for senior NIA staff.

"Seminar subjects were technical, contract administration procedures, and construction methods. Although the seminars were designed for NIA personnel, the local consultants were invited to participate.

"NIA, with the help of a full-time training officer, conducted evaluations and held examinations to monitor individual progress. NIA administration staff were trained during the program with job rotation at six-month intervals."

Effectively Implemented

"The project was on time and within budget estimates and was judged to be most effective by the client and by the World Bank.

"As to skill transfer, the program concentrated on NIA staff and was effective. The major disappointment resulted from 'brain drain' of many of the professionals trained on the project to overseas assignments and to private-sector consultancies.

"The skill transfer to the private consultants resulted from on-the-job training. The consultants' organization worked on a flexible basis, and local consultants progressively became more involved in decision making as the project progressed. Local consultants regretted that they had not participated more at the feasibility stage.

"The foreign consultants were open to skill transfer and responded well to local consultants' individual initiatives. For example, a DCCD engineer travelled to Montreal to assist in complex computer calculations. This engineer returned with not only the calculations but also the methodology and software for large capacity computing, and the company can now perform such calculations in Manila with their own resources.

"Local consultants interviewed stressed the role of the two project managers in building an open, harmonious team. Individuals in the private consultants' organizations gained much in the way of personal reference books and methodology from the expatriates. The two local consultants gained much in management experience in how to conduct large projects."

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Case 3

The Piper Aircraft Corporation Licensing Agreement with Empresa Brasileira de Aeronautica, S.A.

"In 1974, Brazil represented the largest single export market, outranking both Canada and Germany,- for U.S. light aircraft (general aviation) manufacturers. U.S. Manufacturers delivered 726 planes to Brazil in that year at a cost of $600 million. Severely pressed by this time with foreign-exchange constraints and confident of its technical capabilities and sufficient internal market demand, Brazilian development authorities felt it was an appropriate moment for the state-owned aircraft enterprise, Embraer (Empresa Brasileira de Aeronautica, S.A.) to begin a manufacturing program of light aircraft, single-or twin-engine, with the support of and in close cooperation with a foreign aircraft manufacturer.

"In 1974, Brazil sent a mission to the major U.S. small aircraft producers to solicit proposals on an agreement for production by Embraer in Brazil of U.S. planes. Embraer approached Piper, Beech, and Cessna, the last of which held more than 60 per cent of the Brazilian market in 1974.

"According to Embraer, all three firms were fully apprised of the rules of the game; that is, the Brazilians made explicit their intent to develop their own technical, managerial, manufacturing, and marketing capabilities in small aircraft production and to reserve exclusively the domestic market thereafter for Brazilian-produced aircraft. The second goal, it was explained, was not so much an intent to create a protected industry but an effort to realize foreign-exchange savings. Implicit in these rules was the eventual outcome that only the foreign firm prepared to enter into an agreement with Embraer would be permitted continued participation in the large Brazilian market.

"Piper was finally selected. As was portended by Embraer officials prior to entering into negotiations, U.S. exports of small aircraft to Brazil have plummeted. Cessna, which in 1973 sold more than 400 aircraft in the Brazilian market, sold only 5 in 1976. This sales plunge is the result of a 50 per cent tax (raised from 7 per cent) imposed in 1975 on imported planes of this category and the requirement of the Brazilian government that importers make a one-year interest-free deposit covering the full price of manufactured goods bought abroad. In addition, Brazil's law of similars, which has been in existence since the 1890s but of limited application until recently, has severely inhibited aircraft exports to Brazil. The law stipulates that once an item is produced in "sufficient quality and

quantity" in Brazil and registered with the government as a product similar to its imported counterpart, it will be protected from imports.

"The industrial cooperation program with Piper is based upon two agreements - one for single-engine aircraft and one for twin-engine airplanes. Each will be operative at least through mid-1979. Under the terms of the agreements, Embraer may select any Piper model it desires for local production. Thus far, the following models have been chosen: three models of Cherokee aircraft and the Lance, Seneca, and Chieftain.

"Piper is responsible for providing the necessary assembly and parts manufacturing know-how as well as for assisting in such areas as quality control, materials handling, and manufacturing. Piper has an option to use its international distribution system for aircraft that may be exported from Brazil. The U.S. firm's compensation is primarily a percentage return on the components it ships to Embraer. As the licensee progressively substitutes local content for these imports, the returns will diminish. However, even at 100 per cent production in Brazil, Piper still will be paid a fee for service in support of those aircraft. With the exception of those items that cannot be economically produced in Brazil, local substitution is expected to proceed smoothly.

"At the present time, the Piper program is basically a licensing agreement; but in the medium and long term, it could provide for the cooperative development of new aircraft. The agreement specifically permits Embraer to fabricate Piper aircraft for sale in the domestic market and, on occasion, to produce jointly with the U.S. company for foreign market sales; replace on a gradual scale Piper-supplied components with Embraer-fabricated products; initiate joint programs to share development and production of a new aircraft aimed at domestic or foreign markets; and market one another's products through individual distribution networks.

"Production capability for the Piper models is being transferred to Embraer in three phases. During Phase I, completed structures such as fuselage, empennage, and wings are shipped to Embraer for final-assembly and installation of all systems and components. Phase I was completed for the single-engine models in six months and Seneca is now also in Phase II. During Phase II, Embraer receives structured subassemblies for mating in jigs, in addition to the functions achieved in Phase I. By the Phase III, Piper will be shipping all component parts for assembly by Embraer and in three subphases will: (1) begin replacement of Piper-supplied parts by Brazilian-made equivalents, including interiors and 50 per cent of both fiberglass and acrylics; (2) complete replacement of all remaining fiberglass and acrylics and produce all harnesses; and (3) produce the aircraft completely with Brazilian-manufactured parts and components, with the exception of those that cannot be economically produced in Brazil.

"Upon completion of Phase III-3, Embraer projects that from 66 per cent to 70 per cent of the Piper product will be of Brazilian origin based on U.S. price. Single-engine models will reach Phase III-3-by mid-1977, the Seneca by the end of 1977 and the Navajo by mid-1978. Subcontracting is a central feature of the Embraer-Piper production program as well as Embraer's other aircraft programs and was instrumental in allowing the company to begin these projects so quickly. Subcontracting is also vital to the development of other aviation-related industries around Embraer. Over fifty Brazilian national firms participate in the subcontracting network for the country's aerospace industry.

"The primary means employed to develop these supporting industries is a series of partnerships with foreign firms. An effort is made first to make each industry financially capable and then to upgrade-its technical competence to aeronautical standards. To assist and accelerate the latter process, one foreign firm is normally selected for each industry.

"In developing its aeronautics industry, Brazil's specific areas of interest concerning foreign partnerships include both reciprocating and turbine engines, avionics, hydraulics, instrumentation, and raw materials such as aluminum and steel. CTA has begun earnest discussions with a number of foreign firms for the following forms of assistance. A formal agreement is expected to be signed soon-with Lycoming whereby it will help in the development of Brazilian components to be produced by individual vendors. These components include raw materials, forgings, castings, machine parts, and accessories. Teledyne Continental Motors has been approached by CTA for similar assistance. In the field of turbine engines, talks are underway with Pratt and Whitney Aircraft of Canada, Rolls Royce, Lycoming, Garrett, and, to some extent, with General Electric. CTA has been working with Collins, Bendix, King, Narco, and the German firm Becker for the possible production of avionic electronic components in Brazil. A working relationship with the French has already been established for the manufacture of hydraulic components, including landing gears, and other French firms have been engaged in negotiations for production of light alloys and resistance steels. And for the production of flight and power plant instruments, CTA is holding discussions with three U.S. and British companies.

"Brazil is not unique among the more industrialized of the developing countries in its desire to develop an indigenous aircraft industry. It is perhaps unique, though, in it professional approach to achieving that end. Its strategy of effectively closing entry to its markets for all but the foreign firm prepared to share front-end technology, to impart sophisticated design and engineering capabilities, and to instruct Brazilian nationals in managerial skills has been extremely successful. Foreign firms, facing narrowing opportunities to earn returns in foreign markets, have been extremely eager to meet these conditions. Brazil, a state capitalist economy, has the means to accumulate large sums of capital and therefore can exercise considerable leverage in negotiating with foreign firms.

"In time, the sustained enterprise-to-enterprise relationship that characterizes Brazil's effort to develop its aerospace industry will result in the implantation of internationally competitive design,-engineering, and production capabilities. While the U.S.firms that have taken advantage of the opportunities offered by Brazil will benefit, other U.S. firms in the industry can expect increased competition in third-country markets from Brazilian aircraft in the future."

Case 4

The Sale of Motorola's Color TV Manufacturing Assets to Matsushita

"In May 1974, Motorola sold the vast majority of its color TV manufacturing assets and patents to Matsushita Electric Industrial Company, Limited. This sale largely ended the company's involvement in the home entertainment electronics industry; earlier it had phased out production of stereos, phonographs, tape players, and clock, table, and pocket radios. Like other U.S. manufacturers, the company's Consumer Electronics Division had had great difficulty retaining its competitive position in the face of rising imports from Japan, industrial overcapacity in the production of top-of-the-line units, and reduced U.S. consumer purchasing power. The most significant factor that affected Motorola's Market position was Motorola's inability to match the competitive strength of the extremely competent domestic manufacturers, particularly Zenith Radio Corporation. Motorola could not match their research and development expenditures, distribution systems, and production facilities. Zenith's marketing strategies were also important elements. Finally, there was irrational pricing as well as over-capacity in the domestic industry.

"In contrast, Matsushita had over $4 billion in sales, 30 per cent of which derived from its color-TV product line. The company had previously marketed a broad range of consumer electronic products in the U.S. under the Panasonic brand name, and it continues to be the world's largest manufacturer of consumer electronics. Exports accounted for 18 per cent of its total sales in 1973.

"In Japan, Matsushita was known as a "follower company". That is, it was not known to be a frequent innovator of new products; rather it was thought to have achieved a strong market position by simplifying the design and production of items already proven in the market. These improvements usually facilitated either price reduction or product differentiation. In each case, the company was able to attract an enormous clientele through its highly successful promotional efforts.

"Motorola and Matsushita agreed that the purchase price would be slightly above book value, which was determined by an independent audit to be approximately $100 million. The purchase included Motorola's TV production facilities at Franklin Park, Pontiac, and Quincy, Illinois, although Motorola would continue to operate the Quincy Plant until 1976. Motorola's leased assembly operations in Canada and its relevant product inventories were assumed by Matsushita. The U.S. company retained its plant in Taiwan.

"Had the sale been made prior to 1970, a strong outflow of unique technology would have occurred. Between 1966 and 1970, Motorola's Quasar technology was without equal. The company did not, however, maintain its technological leadership in the 1970s. It is therefore probable that at the time of the change of ownership Motorola had little unique technology to transfer to Matsushita's color TV operations. Whatever technological advantages Motorola may have enjoyed in color TV production were no doubt transferred to Japan shortly after the acquisition. Representatives of other firms in the industry have suggested that there was a small initial outflow of unique technology followed by a more significant inflow of technology from the Japanese firm.

"One aspect of the transfer of technology was the granting of certain patent rights by the U.S. firm. Without these patents, the production activities in the Illinois plants could not have continued as before. The acquisition of these patents did not necessarily provide Matsushita with a technological advantage over its U.S. competitors, however.

"Moreover, the Japanese conglomerate, as the world's largest consumer electronics firm, certainly was in a better financial position than Motorola to make substantial investments in technological improvements. Such innovations as three-dimensional pictures, flat screens, miniaturized sets, and home video-tape recorders are perhaps necessary to spur lagging industry sales.

"Circumstances that led to the Motorola-Matsushita deal were indicative of the state of the U.S. consumer electronics industry in the late 1960s and 1970s. Prior to the dramatic rise of Japanese imports, the industry had served American consumers with traditional products. Japanese firms successfully identified market segments that could be better served with innovative products. Once these opportunities were identified, U.S. manufacturers were slow to react.

"Their unresponsiveness led to a rapid deterioration of the market position of U.S. firms and a significant increase in concentration within the industry.

"The actual transfer of technology probably kept jobs in the U.S. (though Matsushita has phased out the Pontiac, Illinois plant); U.S. jobs may have been lost if Motorola had abandoned its color TV operations without having found a buyer. Japanese technology is reportedly now flowing into the Illinois plants, strengthening the American production base and providing benefits to American consumers. Motorola, having divested itself of an unprofitable product line, is presumably a healthier company because it has reoriented its business into areas in which it is better able to compete. Still, the Motorola case offers little consolation to those who had hoped American firms could vigorously respond to the Japanese import challenge."

Case 5

The Fluor Corporation's Transfer of Project Management Techniques to Saudi Arabia

"The Fluor Corporation, one of the largest and most successful engineering companies in the world, is headquartered in Los Angeles and has worldwide operations. Its main line of business has been the chemical and petroleum processing industries, particularly in the design and construction of plants totally under its responsibility. Total responsibility for handling a project has become a hallmark of Fluor. On the average, Fluor does about one-half its business abroad. A dramatic recent example of this trend is that in 1974, Fluor obtained its first billion-dollar contract - in the U.S. as part of the trans-Alaska pipeline - and in 1975, it obtained its second billion-dollar contract, this time outside the U.S. - for the SASOL II plant to extract oil from coal in South Africa. Its biggest contract, signed in June 1975, was for a $4 billion gas-collecting and processing plant in Saudi Arabia.

"Fluor does not license its project management techniques as such. It delivers the techniques only as part of the total-responsibility package of services that it prefers to supply. Through its Bonner and Moore subsidiary, it does offer for sale computer software and consulting services that might form part of the project management techniques. It would be difficult, if not impossible, for a purchaser of these discrete parts of the total technique to reproduce the total technique. In this way, Fluor protects its methods; and in any case, through their constant use and improvement, Fluor is able to make them rapidly obsolete.

"Fluor prefers to maintain complete control of its foreign subsidiaries and always assumes the dominant control on its foreign construction work. In this way, it is able to control access to its management technologies and to those items of proprietary engineering technology that it has developed.

"However, in some cases, such as that of its Iranian subsidiary (and until recently its Taiwanese subsidiary), Fluor has found that the only way to establish a local operation is through partnership with local interests. One of the reasons that these subsidiaries appear to do less well than its 100 per cent owned subsidiaries may well be that they do not have the same freedom of access to Fluor's latest techniques.

"Fluor's two key management tools for project planning and control are designated with acronyms that are descriptive of the techniques: FACT (Fluor Analytical Cost Trending) and FAST (Fluor Analytical Scheduling Technique). Both techniques are computerized. FACT is of greatest importance at the beginning of a project, as decisions made then have the most effect on the project's final cost. Early cost estimates are constantly updated as new data are received and the cost trend of each item is plotted before firm commitments are made. Any change affecting cost can be quickly evaluated and reported. A daily check of cost trend versus budget is kept so that the project manager can take corrective action in good time. FACT provides the project manager and client with computer-printed reports of accumulated labor costs, material commitments and expenditures, and a summary report of project costs and forecasts.

"FAST, on the other hand, uses a computer-assisted critical path diagram to provide a graphic plan of project progress. It is initiated by a step-by-step identification of each activity that is to be performed to complete the project and the sequence and time required for each activity. These are arranged mathematically on the logical "best" plan, which then become the norm for evaluating actual performance. If necessary, the basic plan can be modified. The computer-printed reports show the project manager and client the effect of each actual event and activity on the plan as each occurs so that early corrective action can be taken when necessary. An important feature of FAST is that it enables the project manager and client to analyze the effect of a proposed technical or procedural change on the project schedule before the change is implemented.

"Fluor also has a scheduling tool called PROMPT (Progress Reporting of Material Procurement and Transportation), which supplements the overall FAST schedule by providing specific details on purchased equipment and materials. At new job sites, Fluor installs a computer terminal to provide rapid access to this program, as well as to FACT and FAST, and thereby to allow the management on-site (both Fluor's and the client's) to be intimately involved in the control of the project.

"The construction manager will have the best of both worlds if he can successfully blend the skills and experience of his company with those of the local people. He will often try to maximize the involvement of the local people, especially the subcontractors, who will thus become trained in his firm's ways and will be available for future work. A fine line has to be observed in training the local contractors between making them efficient subcontractors in the future and preparing them to be potential competitors. Generally, in the design and construction of sophisticated modern chemical and petroleum plants, there is not much danger of the local subcontractor becoming a competitor, except in highly developed areas, such as Western Europe. For this reason, Fluor will usually hire all its construction workers directly for work there and avoid the use of subcontractors entirely.

"The $4 billion gas-collecting and processing job in Saudi Arabia will generate as much as $3 billion in equipment orders most of which will be filled in the U.S. The Saudi Arabian job may be exceptional in this regard, inasmuch as the Saudis have instructed Fluor to maximize the amount of equipment and the degree of engineering obtained in the U.S. U.S. prices - both for equipment and for engineering - are now very competitive, so the Saudi instruction is clearly self-serving. The arrangement is also in the best interests of the U.S. because it represents a substantial boost to the equipment industry and its suppliers. At least 50 per cent of an equipment order will go into direct payments to the equipment suppliers' work forces or that of the subsuppliers. One can, therefore, translate the $3 billion Saudi equipment order into a substantial number of jobs in the U.S. If it is estimated that the average cost of a worker is $30,000 per year and that half of the $3 billion goes to pay labor costs, some 50,000 man-years will be needed to fill the Saudi order. The equipment will be supplied over some two to three years, so the order could be supporting some 20,000 workers during that period.

"The remaining $1 billion of the Saudi contract will go into engineering and construction. With the instruction to maximize the amount of American involvement in these phases, it would not be far-fetched to say that 75 per cent of the $1 billion would pay for U.S. services. U.S. engineers, construction workers, and supervisors probably cost a company like Fluor an average of $100,000 per year each. The $750 million for engineering and construction, therefore, would translate into 7,500 man-years of effort. As the total job will last some three to four years, one can say that more than 2,000 U.S. engineering and construction personnel will be employed on the Saudi contract.

"As was mentioned previously, the Saudi job is exceptional both in its size and in its instruction to maximize U.S. involvement. It does demonstrate, however, the potential for the U.S. chemical engineering industry to generate immediate returns to the U.S. economy for the relatively marginal cost of seeming to give away "vital" U.S. technology. As was also mentioned, the improvements to the technology made by putting it into practice, may soon make that which was transferred more obsolete than vital."

Case 6

The Cummins Engine Company's Agreement with Komatsu, Ltd., for the Manufacture of an Advanced-design Diesel Engine

"In 1973 the Cummins Engine Company, the world's largest producer of diesel engines negotiated an agreement with its Japanese licensing partner, Komatsu, Ltd., for the production of a major portion of the components for its new K engine. The K engine was Cummins' newest-generation diesel engine - representing seven years of research - and was born in response to Cummins' perception of future demand in the power market in the 1970s. Specifically, it was anticipated that sizable markets would

open up in the 400-600 hp and 800-1200 hp range, and the K engine has been clearly the most competitive product developed to date to meet that demand. It was largely Cummins' assessment of its strengths in the engine field, coupled with the necessity to conserve capital, that influenced its decision to source production of the most capital-intensive components of the K engine.

"It was generally agreed that the strength and prominent position Cummins enjoyed in the diesel engine market was derived largely from its technological leadership in the engine field and the efficient network of distributions it possessed to service the ultimate customer. The actual manufacturing of the engine, however demanding in sophisticated skills, could be done equally well by other producers. Assigning production to another manufacturer would free a substantial portion of Cummins' resources for concentration in areas in which it enjoyed an advantage over other producers in the market - designing and marketing engines.

"The size of the requisite capital outlay coupled with the uncertainties in returns attending production of the K engine in the U.S. prompted Cummins' management to revise their plans and consider alternative production locations. In their deliberations, Cummins' management focused on two seemingly unrelated factors. First, Cummins was an international company committed to worldwide participation, and second, its largest competitor in the off-highway market, Caterpillar, was beginning to make inroads into the U.S. automotive market. Combined, these two factors directed attention to one of Caterpillar's largest international competitors and one of Cummin's long-standing and major licensees, Komatsu, Ltd., in Japan.

"Through ten years of license agreements to manufacture the NH engine Cummins had developed considerable appreciation for Komatsu's ability to undertake sizable orders for engine manufacturing and to produce engines that met Cummins' high standards. Komatsu is a vertically integrated equipment manufacturer with production facilities at least as modern as Cummins' facilities. Komatsu's foundry, in fact, is far superior to those commonly found in the U.S., and its machinery operations employ technology as advanced as that used by Cummins. Labor-capital ratios are quite comparable to those at Cummins. Finally, Komatsu's corporate management was highly respected by Cummins for its sharp perception of market forces, its success in differentiating its products from top-level foreign brands through high quality, and its boldness in entering new markets, most notably the Eastern European market. They also had succeeded in penetrating the Chinese (PRC) market.

"The terms of the contract called for the production by Komatsu of eight major components of the six- and twelve-cylinder versions of K series engines. Those eight components were selected on the basis of their high capital intensity. If they were produced in the U.S., they would require 77 per cent of the total capital investment through 1976. Additionally, they contain 44 per cent of the total material content and utilize 31 per cent of the total labor content of the base K engine assembly. At present, Cummins purchases the eight components from Komatsu and carries out final assembly and testing of the engines in its Charleston, South Carolina, and Daventry, England, facilities. In all likelihood, the complete engines will eventually be manufactured by Komatsu and purchased by Cummins at a prearranged price.

"Cummins' decision to share the production function of its new generation of diesel engines with Komatsu arose largely out of its severe capital constraints - a not uncommon malady suffered by many U.S. firms in recent years. In fact, to speak of the agreement as an alternative to completely manufacturing the new engine in U.S. facilities would be euphemistic; in all likelihood, Cummins could not afford to produce the K engine without such a strong - financially and technically - partner as Komatsu. Therefore, a major benefit of the agreement for Cummins is the ability and means with which to introduce into the market a highly competitive product for which, according to all indicators, there will be a large demand. In addition, by relieving itself of producing all but 20 per cent of the K engine, Cummins took a major step toward implementing its new strategy of focusing its resources on technology and marketing rather than manufacturing.

"The major benefit enjoyed by Komatsu, Ltd., as a result of the agreement was further infusion of very sophisticated technology. In its earlier licensing arrangement with Cummins, Komatsu acquired a vast array of technical knowledge that allowed it to achieve considerable success in some of its machinery. Komatsu was manufacturing a quality-equivalent Cummins diesel within less than two years after the license agreement had been signed.

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"In the manufacturing of a diesel engine for commercial trucks, there are approximately 750 parts, ranging from cylinder blocks to fuel injector pins. Each part may require anywhere from 5 to 75 separate process steps to produce a finished part. In the U.S., close to 200 plants supply Cummins with materials, raw castings, forgings, components, and parts. To produce these parts, as many as 300 different materials are required, and there are narrow standards on physical and chemical characteristics and shapes of finishes for each of them. Approximately 15,000 manufacturing steps are required to convert materials and castings into finished parts for a single engine model. To be involved from the very beginning, and in such an extensive manner, in the manufacture of the newest generation of diesel engines is indeed a great boon to Komatsu's already sizable reservoir of technical and production-engineering expertise. The agreement can also be expected to expand Komatsu's already established link to the U.S. market.

"The U.S. economy does not fare quite as well from the agreement as do the two signatories. It is true that capital constraints eliminated Cummins as the major manufacturer of its new engine and that Komatsu, given its former relationship with Cummins and reputation in the field, represented a logical candidate. Nevertheless, the fact that the bulk of the production is sourced from Japan translates into a loss of jobs and income for the U.S. Equally important, it means that the know-how for the newest generation of a highly sophisticated U.S. product has been released to a foreign, non-controlled affiliate. And, in this case, the affiliate has already demonstrated itself to be fully capable of absorbing advanced technology as well as astute and successful in entering new markets.

"It is not at all clear whether Cummins would have entered into the agreement had it not suffered from such severe capital shortages or had there been a suitable merger arrangement that would have furnished the additional capital required. The problem created for American firms by the U.S. capital market and antitrust laws plays an important role in such decisions and requires close examination. Unfortunately, these topics are not within the scope of this paper. It is clear, however, that the agreement has resulted in a further erosion of the U.S. production and technological base."

Case Summaries and Overview of Policy Implications

Following are tabular summaries of the cases of technology transfer described in J. Baranson's book. The summaries are useful because they isolate and identify the kind of technology that has been transferred, as well as the corporate motives for inviting and effecting the transfers. The "Policy Implications" deal largely with the long-term impact of the transfers on the competitive positions of the countries involved.

Case Summaries:

Aircraft Industry

Case studies	Technology transferred	Corporate considerations	Purchaser considerations
General Electric - SNECMA (France)/joint venture.	Design and production of high technology, advanced-design jet engine for civilian aircraft.	Fear of being precluded, even on a partial basis, from lucrative European market.	Necessity to accept strong foreign partner to obtain internationally competitive technology. Strong backing of French Government to acquire design and engineering.
General Dynamics - European Consortium/ coproduction agreement.	Production technology for advanced fighter aircraft.	Sale of technology helps amortize huge R&D costs. Need to maintain technological lead to remain internationally competitive.	Insistence by purchaser government on coproduction and offset purchase arrangements.
Piper Aircraft - EMBRAER (Brazil)/licensing agreement.	Production technology for civil aircraft.	Need to maintain technological lead and production competitiveness against future Brazilian export capabilities.	Piper preempted from export by Brazilian import restrictions. Brazilian government interest in developing national design and production capabilities.

Overview of Policy Implications:

Aircraft Industry

Case studies	Corporate planning	U.S. economy	Newly industrializing nation (NIN)
General Electric - SNECMA General Dynamics - European Consortium	Foreign firm(s) assisted to point of becoming major innovator and competitive threat to U.S. industry.	Progressive erosion of U.S. technological lead as result of release of advance technology systems and imparting design-engineering capabilities.	
Piper Aircraft - EMBRAER		Prospect foreign associate may become low-cost producer of product.	Opportunity for NIN enterprise to enter into world market competitive basis - including upgrading of industrial design and engineering capabilities.

Case Summaries:

Consumer Electronics Industry

Case studies	Technology transferred	Corporate considerations	Purchaser considerations
GTEI-SONELEC (Algeria)/ turn-key contract.	Plant construction, manufacturing technology (fully integrated from raw material to radio and TV) and training of full-range of managers and technicians.	Opportunity to earn substantial return on technology assets without capital resources commitment.	Oil revenues permitted. Government to finance industrial facility. Want self-sufficient operational and eventually design engineering to compete in world market.
Motorola-Matsushita (Japan)/ divestiture.	TV manufacturing plant and patents sold to Matsushita.	U.S. firm decided to phase out its involvement in consumer electronics field in face of mounting R&D costs and intensified competition from foreign (Japanese) imports. Divestiture came at time when consumer demand had fallen off in U.S. market.	Matsushita gained some manufacturing know-how (less in product design). Company able to expand product line worldwide and rapidly penetrate U.S. market.
RCA/Corning - UNITRA (Poland)/licensing agreement.	Product design, plant engineering, manufacturing know-how, and technical training for cathode-ray tubes.	Financially remunerative opportunity to earn return on technology asset in otherwise inaccessible market.	Polish enterprise interested in internationally competitive production capability to supply domestic and Eastern European market.

Overview of Policy Implications:

Consumer Electronics Industry

Case studies	Corporate planning	U.S. economy	Newly industrializing nation (NIN)
Motorola - Matsushita	Global prospect that astute industrial enterprise will use acquired technology as plateau from which to design and engineer future product systems.	Erosion of U.S. production jobs occurs when foreign assembler in U.S. begins to displace U.S. component , content (future possibility in Motorola-Matsushita type of situation).	
RCA/Corning - UNITRA		Release of technology to foreign partner(s) with high technical absorptive capabilities leads to rapid development of international competition.	
RCA/Corning - UNITRA, GTEI-SONELIC			Management service contracts provide opportunity for NIN enterprises to develop an internationally competitive industry, including training of vital technical and managerial personnel.

Case Summaries:

Chemical Engineering Industry

Case studies	Technology transferred	Corporate considerations	Purchaser considerations
UOP - Foreign auto firms with U.S. export markets/licensing agreement.	Catalysts and catalyst containers for catalytic converters.	Process company focuses on the development and sale of successive generations of innovative technology; product firm, the Automotive Division, retains control over technology and manufacture and returns profit factor to company for each unit sold.	Foreign auto makers with U.S. export markets compelled by law to install emission control devices to maintain market share.
Sohio - People's Republic of China (PRC)/licensing agreement.	Process technology for synthetic fiber feedstock (acrylonitrile). Through Japanese engineering intermediary includes plant engineering and training of engineering personnel.	Acting here as a process engineering firm (as distinct from product firm with concern over world future market shares), prime consideration is maximizing revenues from technical innovation.	PRC anxious to acquire up-to-date operative technology with export potential and at the same time lay base for adaptive engineering of related families of chemical facilities.
Fluor - Iran and Saudi Arabia/turn-key contracts.	Engineering and construction of chemical and petroleum processing facilities, with a strong emohasis on efficient and rapid installation (Saudi Arabia - a natural gas collection plant; Iran - a series of refineries).	Process and plant engineering firm's basic interest in maximizing returns from sale of design and engineering services anywhere in the world (over half of $10 billion in contracts now overseas). In order to maintain commercial and technological lead in world, firm must improve its cost competitiveness by constantly upgrading its efficiency in project management.	Saudi Arabia anxious to expand its domestic processing of oil and natural gas resources. Strong drive in Iran to develoo local exoertise in project management.

Overview of Policy Implications:

Chemical Engineering Industry

Case studies	Corporate planning	U.S. economy	Newly industrializing nation (NIN)
General	Important distinction between "product" and "design-engineering" companies in the logistics of developing successive generations of technologies and marketing them to other enterprises (domestic and foreign).		
Sohio - PRC			NIN enterprises can negotiate contracts that move beyond turn-key operations into self-sustaining design engineering capabilities.
Sohio - PRC Fluor - Iran and Saudi Arabia		Chemical engineering industry stands as a model to the measured release of industrial technology with refurnishment of stock of technology through R&D funded by corporate returns. Potential threat to U.S. production jobs comes from internationally competitive facilities producing commodities for world markets.	
UOP - Foreign auto		Safety and energy conservation regulations can have important impact on relative competitiveness of U.S. industry.	

Case Summaries:

Automotive Industry

Case studies	Technology transferred	Corporate considerations	Purchaser considerations
General Motors - Polmot (Poland)/coproduction agreement.	Design and production for new line of commercial trucks to be marketed internationally.	Opportunity to earn corporate return on Eastern European and segment of Western European markets that would otherwise be, respectively, inaccessible or require prohibitively high capital investment.	Polish government wanted training of technicians and managers in production design operations as well as in engineering. Polmot wanted rapid placement of internationally competitive facility to earn foreign exchange.
Cummins Engine - Komatsu (Japan)/licensing agreement.	Manufacturing technology for advanced design diesel engine.	Severe capital constraints prompted company to assign major manufacturing responsibilities to former Japanese licensee.	Komatsu anxious to take on major manufacturing role for world market.
Gama Auto - Socialist country/licensing agreement.	Manufacturing technology for latest generation automotive part.	Corporate plan is to develop generation of manufacturing technology that will cut costs by 40% before purchaser is ready to enter and compete in international market.	Purchaser government anxious to obtain most modern and up-to-date facility to manufacture auto components to internationally competitive standards.
Bendix - Bosch (Germany)/cross-licensing agreement.	Know-how to manufacture electronic fuel injection.	Necessary to license front-end technology to strong technical partner with dominant market position in order to earn return, to avoid patent infringement claims, and to benefit from technology exchange.	German firm able to maintain its technological parity with U.S. firm through cross-licensing arrangement. European auto market demand ahead of United States for this technical innovation.

Overview of Policy Implications:

Automotive Industry

Case studies	Corporate planning	U.S. economy	Newly industrializing nation (NIN)
Cummins Engine - Komatsu	Future emphasis in U.S. enterprise on marketing and product research and internationalizing function.		
Bendix - Bosch		Cross licensing arrangements reinforce competitive position of foreign vis-à-vis other U.S. firms.	
Gamma Auto - Socialist country, General Motors - Polmot		U.S. firm contributes to export competitiveness of foreign manufacturer and potential job erosion in U.S. production base.	
General Motors - Polmot			Opportunities for NIN enterprise to enter into coproduction, comarketing arrangements.

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